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CLAIMS

1. A method to locate a fault from one end of a section of a power line (A-B) by means of measurements of current, voltage and angles between the phases at a first (A) end of said section,
characterised by
- calculating symmetrical components of currents for said current and voltage measurement at said first end (A),
- calculating a value of impedance for an extra link (45, 55) between the terminals (A,B) with the impedance for the positive sequence equal to:

$(\underline{Z}_{1LB\&AB} = \dfrac{\underline{Z}_{1LB}\underline{Z}_{1AB}}{\underline{Z}_{1LB} + \underline{Z}_{1AB}})$ where:

$\underline{Z}_{1AB}$ = impedance for the positive sequence of the extra link,

$\underline{Z}_{1LA}$ = positive-sequence impedance of the healthy line,

- determining a compensation for the shunt capacitance with the aid of an equation (22) of the form:

$$B_2^{comp-1}(d_{comp\_1})^2 + B_1^{comp-1}d_{comp\_1} + B_0^{comp-1} = 0 \text{ where:}$$

$$B_2^{comp-1} = A_{2\_Re}^{comp-1}A_{00\_Im}^{comp-1} - A_{2\_Im}^{comp-1}A_{00\_Re}^{comp-1}$$

$$B_1^{comp-1} = A_{1\_Re}^{comp-1}A_{00\_Im}^{comp-1} - A_{1\_Im}^{comp-1}A_{00\_Re}^{comp-1}$$

$$B_0^{comp-1} = A_{0\_Re}^{comp-1}A_{00\_Im}^{comp-1} - A_{0\_Im}^{comp-1}A_{00\_Re}^{comp-1}$$

- determining the zero-sequence current from the healthy line of a section of parallel power lines,
- calculating a distance to a falt for the parallel line section,
- calculating the distance (d) to the fault (F) from said first end (2) using a quadratic equation (26) of the form:

$B_2 d^2 + B_1 d + B_0 = 0$ where:

$B_2 = A_{2\_Re}A_{00\_Im} - A_{2\_Im}A_{00\_Re}$

$B_1 = A_{1\_Re}A_{00\_Im} - A_{1\_Im}A_{00\_Re}$

$B_0 = A_{0\_Re}A_{00\_Im} - A_{0\_Im}A_{00\_Re}$

2. A method according to claim 1, **characterised** by calculating the distance (d) to the fault using an equation of the form:

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$$\underline{K}_1\underline{Z}_{1L}d^2 + (\underline{L}_1\underline{Z}_{1L} - \underline{K}_1\underline{Z}_{AA\_p})d - \underline{L}_1\underline{Z}_{AA\_p} + R_F\underline{M}_1\frac{(\underline{a}_{F1}\Delta\underline{I}_{AA1} + \underline{a}_{F2}\underline{I}_{AA2})}{\underline{I}_{AA\_p}} = 0 \qquad (8)$$

where:

$$\underline{Z}_{AA\_p} = \frac{V_{AA\_p}}{\underline{I}_{AA\_p}} \text{ - calculated fault loop impedance.}$$

5 3. A method according to any of claim 1 or 2, **characterised** by calculating the distance (d) to the fault using an equation of the form:

$$\underline{A}_2 d^2 + \underline{A}_1 d + \underline{A}_0 + \underline{A}_{00} R_F = 0$$

10 where:

$$\underline{A}_2 = A_{2\_Re} + jA_{2\_Im} = \underline{K}_1\underline{Z}_{1LA}$$
$$\underline{A}_1 = A_{1\_Re} + jA_{1\_Im} = \underline{L}_1\underline{Z}_{1LA} - \underline{K}_1\underline{Z}_{AA\_p}$$
$$\underline{A}_0 = A_{0\_Re} + jA_{0\_Im} = -\underline{L}_1\underline{Z}_{AA\_p}$$
$$A_{00\_Re} + jA_{00\_Im} = \frac{\underline{M}_1(\underline{a}_{F1}\Delta\underline{I}_{AA1} + \underline{a}_{F2}\underline{I}_{AA2})}{\underline{I}_{AA\_p}}$$

15 $$\underline{Z}_{AA\_p} = \frac{V_{AA\_p}}{\underline{I}_{AA\_p}} = \text{calculated fault loop impedance}$$

$\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ = coefficients gathered in TABLE 3.

4. A method according to one or more of the preceding claims, **characterised** by
20 - determining source impedance at said first end as a representative value, and
- determining a value for source impedance at said second end as a representative value.

25 5. A method according to one or more of the preceding claims, **characterised** by calculating symmetrical components of currents for said current and voltage measured at said first end by:
- inputting instantaneous phase voltages (30a),
30 - filtering (33a) the values to determine the phasors, and
- calculating (34a) phasors of symmetrical components of voltages.

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6. A method according to one or more of the preceding claims, **characterised** by calculating symmetrical components of currents for said current and voltage measured at said first end by:

5 - inputting instantaneous phase currents and instantaneous zero-sequence current from a healthy line (30b),
- filtering (33b) the values to determine the phasors, and
- calculating (34b) phasors of symmetrical components of currents.

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7. A method according to one or more of the preceding claims, **characterised** by determining a compensation for shunt capacitance by means of an equation of the form:

$$\underline{A}_2^{comp\_1}(d_{comp\_1})^2 + \underline{A}_1^{comp\_1}d_{comp\_1} + \underline{A}_0^{comp\_1} + \underline{A}_{00}^{comp\_1}R_F = 0 \tag{21a}$$

15 where:

$$\underline{A}_2^{comp\_1} = A_{2\_Re}^{comp\_1} + jA_{2\_Im}^{comp\_1} = \underline{K}_1\underline{Z}_{1L}^{long}$$

$$\underline{A}_1^{comp\_1} = A_{1\_Re}^{comp\_1} + jA_{1\_Im}^{comp\_1} = \underline{L}_1\underline{Z}_{1L}^{long} - \underline{K}_1\underline{Z}_{A\_p}^{comp\_1}$$

$$\underline{A}_0^{comp\_1} = A_{0\_Re}^{comp\_1} + jA_{0\_Im}^{comp\_1} = -\underline{L}_1Z_{A\_p}^{comp\_1}$$

$$\underline{A}_{00}^{comp\_1} = A_{00\_Re}^{comp\_1} + jA_{00\_Im}^{comp\_1} = \frac{\underline{M}_1(\underline{a}_{F1}\Delta\underline{I}_{AA1} + \underline{a}_{F2}\underline{I}_{AA2})}{\underline{I}_{A\_p}^{comp\_1}}$$

20 $\underline{Z}_{A\_p}^{comp\_1} = \dfrac{\underline{V}_{A\_p}}{\underline{I}_{A\_p}^{comp\_1}}$ – fault loop impedance calculated from:

$\underline{V}_{A\_p}$ – original (uncompensated) fault loop voltage,

$\underline{I}_{A\_p}^{comp\_1} = \underline{a}_1\underline{I}_{A1\_comp\_1} + \underline{a}_2\underline{I}_{A2\_comp\_1} + \underline{a}_0\underline{I}_{A0\_comp\_1}$ – fault loop current composed of the positive (12), negative (16) and zero (17) sequence currents obtained after deducing the respective

25 capacitive currents from the original currents, and
$\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ = coefficients gathered in TABLE 3.

8. A method according to one or more of the preceding claims, **characterised** by measuring the source impedance $\underline{Z}_{1sA}$

30 at said first end A.

9. A method according to one or more of the preceding claims, **characterised** by
-measuring the source impedance $\underline{Z}_{1sB}$ at said second end B,

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-sending a communication of the measured value of source impedance $\underline{Z}_{1sB}$ at said second end B to a fault locator at said first end A.

10. A method according to one or more of the preceding claims, **characterised** by determining the distance to a single phase to ground fault without measurements from an operating healthy parallel line by means of complex coefficients $\underline{P}_0$ according to a formula of the form:

$$\underline{P}_0 = \frac{\underline{Z}_{0LB} - \underline{Z}_{0m}}{\underline{Z}_{0LA} - \underline{Z}_{0m}}$$

and $\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ according to

$$\underline{K}_1 = -\underline{Z}_{1LA}(\underline{Z}_{1sA} + \underline{Z}_{1sB} + \underline{Z}_{1LB})$$

$$\underline{L}_1 = -\underline{K}_1 + \underline{Z}_{1LB}\underline{Z}_{1sB}$$

$$\underline{M}_1 = \underline{Z}_{1LA}\underline{Z}_{1LB} + \underline{Z}_{1LA}(\underline{Z}_{1sA} + \underline{Z}_{1sB}) + \underline{Z}_{1LB}(\underline{Z}_{1sA} + \underline{Z}_{1sB})$$

11. A method according to one or more of the preceding claims, **characterised** by determining the distance to a single phase to ground fault without measurements from switched off and grounded parallel line by means of complex coefficients $\underline{P}_0$ according to

$$\underline{P}_0 = -\frac{\underline{Z}_{0LB}}{\underline{Z}_{0m}}$$

and $\underline{K}_1$, $\underline{L}_1$, $\underline{M}_1$ according to

$$\underline{K}_1 = -\underline{Z}_{1LA}$$

$$\underline{L}_1 = \underline{Z}_{1LA} + \underline{Z}_{1sB}$$

$$\underline{M}_1 = \underline{Z}_{1sA} + \underline{Z}_{1sA} + \underline{Z}_{1LA}$$

12. A method according to one or more of the preceding claims, **characterised** by determining the distance to a single ground fault using a first order formula (27a,b,c) of the form:

$$d = \frac{imag\{\underline{V}_{AA\_p}[3(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}{imag\{(\underline{Z}_{1LA}\underline{I}_{AA\_p})[3(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}$$

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13. A method according to one or more of the preceding claims, **characterised** by determining the distance to a phase-to-phase ground fault using pre-fault measurements and a first order formula (28a,b,c) of the form:

$$d = \frac{imag\{\underline{V}_{AA\_p}[\underline{W}(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}{imag\{(\underline{Z}_{1LA}\underline{I}_{AA\_p})[\underline{W}(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})]^*\}}$$

14. A method according to one or more of the preceding claims, **characterised** by determining the distance to a phase-to-phase ground fault avoiding pre-fault measurements and using a first order formula (29a,b,c) of the form:

$$d = \frac{imag[(\underline{V}_a + \underline{V}_b)(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})^*]}{imag[\underline{Z}_{1LA}(\underline{I}_a + \underline{I}_b + 2\underline{k}_0\underline{I}_{AA0} + 2\underline{k}_{0m}\underline{I}_{AB0})(\underline{I}_{AA0} - \underline{P}_0\underline{I}_{AB0})^*]}$$

15. A device for locating a fault from one end of a section of a power line (A-B) having means for receiving and storing measurements of current, voltage and angles between the phases at one first end (A), means for receiving and storing a detection of a fault condition between said first and second ends (A,B), **characterised** by:
- means for calculating symmetrical components of currents for said current and voltage measured at said first end (A),
- means for calculating a value of impedance for an extra link (45, 55) between the terminals (A,B),
- means for determining a compensation for shunt capacitance,
- means for determining the zero-sequence current from the healthy line of a section of parallel power lines,
- means for calculating a distance to a fault for the parallel line section,
- means for calculating a distance (d) from said first end (2) to the fault (F).

16. A device according to claim 15, **characterised** by comprising:
- means for determining a value for source impedance at said first end,

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- means for determining a value for source impedance at said
second end.

17. A device according to one or more of claim 15 or 16,
characterised by comprising:
- means for receiving a measurement of source impedance at
said first end A.

18. A device according to one or more of claims 15-17,
characterised by comprising:
- means for receiving a measurement of source impedance made
at said second end B.

19. A device according to one or more of claims 15-17,
characterised by comprising means to receive a measured
value (9) for remote source impedance at said second end (B)
communicated by means of a communication channel (60).

20. Use of a fault locator device according to any of claims
15-19, by a human operator to supervise a function in an
electrical power system.

21. Use of a fault locator device according to any of claims
15-20, by means of a process running on one or more compu-
ters to supervise and/or control a function in an electrical
power system.

22. Use of a fault locator device according to any of claims
15-21, to locate a distance to a fault in a power transmiss-
ion or distribution system.

23. Use of a device according to any of claims 15-22, for
locating a fault on parallel power lines.

24. A computer program comprising computer code means and/or
software code portions for making a computer or processor
perform any of the steps of claims 1-14.

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25. A computer program product according to claim 24
comprised on one or more computer readable media.